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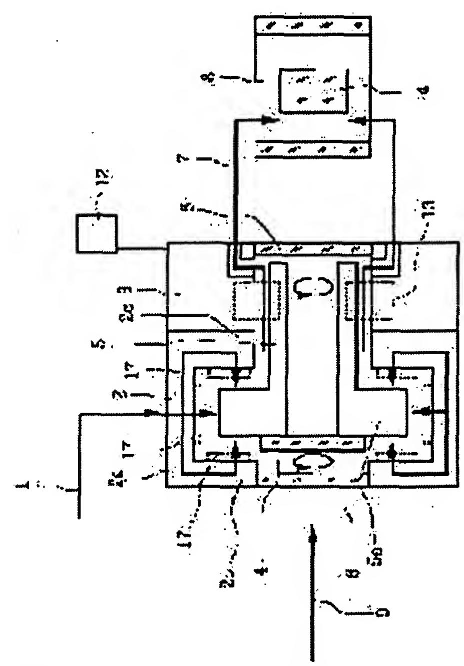
(72)Inventor : MATSUSHITA TOSHIICHI

(54) FLUID BEARING MOTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce the necessary flow rate of a fluid by eliminating necessity of a temperature regulating cover and an exhaust unit, and optimally cooling corresponding to a heating amount change in association with a change of a rotational speed.
SOLUTION: A fluid bearing motor comprises a fluid bearing having a bearing fixing part 2 and a bearing rotary part 5, and a driving mechanism having a motor 3 in a structure for passing the fluid of the bearing through the vicinity of the heating part of the motor 3. In this case, nitrogen in supplied as the fluid to the bearing, the nitrogen is again collected, and reused for replacing the nitrogen in a purging space 8 at the other place.



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CLAIMS

[Claim(s)]
[Claim 1] The fluid bearing motor characterized by being the structure which it has the drive equipped with a fluid bearing and the motor section, and the fluid of the aforementioned fluid bearing passes through near the exoergic section of the aforementioned motor section, and cools this motor section.
[Claim 2] The fluid bearing motor according to claim 1 characterized by supplying nitrogen to the aforementioned fluid bearing as a fluid, collecting the nitrogen again, and reusing to the nitrogen purge of other places.
[Claim 3] The fluid bearing motor according to claim 1 characterized by cooling beforehand the fluid supplied to the aforementioned fluid bearing.
[Claim 4] The fluid bearing motor according to claim 1 characterized by changing the temperature of the fluid supplied to the aforementioned fluid bearing according to the calorific value of the aforementioned motor section.
[Claim 5] The fluid bearing motor according to claim 1 characterized by changing the fluid flow supplied to the aforementioned fluid bearing according to the calorific value of the aforementioned motor section.
[Claim 6] The fluid bearing motor according to claim 1 characterized by pouring another fluid into which the flow direction of a fluid is changed.
[Claim 7] The semiconductor aligner characterized by driving using a fluid bearing motor according to claim 1 to 6, and carrying out the projection imprint of the pattern of the original editions, such as a reticle, on the field of transferred objects, such as a wafer.
[Claim 8] The device manufacture method characterized by manufacturing a device using a semiconductor aligner according to claim 7.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention is equipped with a fluid bearing and the motor section about the motor used suitable for the drive of the semiconductor aligner which carries out the projection imprint of the pattern of the original editions (for example, reticle etc.) on the field of transferred objects (for example, wafer etc.), and a fluid is related with the self-cooling type fluid bearing motor which can self-cool generation of heat of the motor section.
[0002]
[Description of the Prior Art] Conventionally, in the semiconductor aligner, a still higher equipment precision (for example, alignment precision of a wafer and a reticle and imprint precision to the wafer of a reticle pattern), high productivity, etc. are searched for with detailed-izing of a semiconductor device. In order to realize it, positioning accuracy and a high-speed drive also with the still more expensive drive of each part of the inside of an aligner are called for. For example, also in the lighting optical system which illuminates a reticle, the guide section rigidity rise (although it is made to drive weight rise) for raising high-speed movement for raising enlargement of the optical element (object to drive) for acquiring the equalization effect and a throughput in the drive to which it is made to rotate at high speed, or an optical element is moved, and positioning accuracy etc. is needed. Therefore, as for the actuator used for the above-mentioned drive, the motor with more large power (power consumption) etc. has been needed. Consequently, the heating value generated from the actuator which became large [power] has also increased increasingly.
[0003] On the other hand, the drive precision and alignment precision of a wafer or a reticle will get worse by thermal expansion, measurement value change, etc., if a temperature change happens inside equipment. The temperature change permitted in order to satisfy a high equipment precision is becoming still severer with detailed-izing of a semiconductor device. Although the whole aligner is covered with covering and temperature management of the whole equipment is performed in an aligner in order to realize required temperature management, the part where especially temperature management is important establishes a temperature control mechanism individually, and is performing temperature management (individual air-conditioning).
[0004] Furthermore, especially when there are big sources of generation of heat, such as a large motor of the above power, the portion is individually covered with covering, the temperature on the front face of covering is lowered by performing the heat exhaust air inside the covering, and temperature management has reduced the influence of the temperature change to an important portion.
[0005]
[Problem(s) to be Solved by the Invention] However, since the heat exhaust of the exclusive use which performs the heat exhaust air inside covering was required or it was wrap structure about the whole source of generation of heat, the structure of covering became large and the big space space was required of the above-mentioned conventional example. Moreover, in order to connect the pipe for heat exhaust air (duct) between the source of generation of heat, and the heat exhaust, the big space space

also for pipe leading about etc. was needed. Furthermore, although the aligner was carrying out position control of the structure which supports a reticle and a wafer with high degree of accuracy in order to realize high positioning accuracy of a wafer and a reticle, when the source of generation of heat had been arranged at the structure by which position control was carried out, the pipe of heat exhaust air told vibration of the heat exhaust to the structure by which position control was carried out, and worsening the positioning accuracy of a wafer and a reticle has not been disregarded, either.
[0006] this invention has a self-cooling function, temperature control covering and its exhaust are unnecessary, it can perform optimal cooling corresponding to the calorific value change accompanying rotational frequency change, and aims at offering the fluid bearing motor which can reduce the flow demand of a fluid.
[0007]
[The means and operation] for solving a technical problem In order to solve the above-mentioned technical problem, the fluid bearing motor concerning this invention is characterized by being the structure which it has the drive equipped with a fluid bearing and the motor section, and the fluid of the aforementioned fluid bearing passes through near the exoergic section of the aforementioned motor section, and cools this motor section. Moreover, self-cooling of the exoergic section can be carried out by considering as the structure where this invention is the pneumatic bearing motor which consists of high positioning accuracy, a fluid bearing (especially pneumatic bearing) which realizes high-speed rotation, and the high power motor section, and air flows the exoergic section neighborhood of a motor. Therefore, covering and exhaust heat equipment are made unnecessary.
[0008]
[Example] (The first example) The first example of this invention is explained below. Drawing 1 is the block diagram showing the fluid bearing motor concerning the first example of this invention. This fluid bearing motor is equipped with the bearing rotation section 5 which constitutes the fluid bearing as a drive guide for rotating the bearing fixed part 2 to which the nitrogen supply line 1 is connected, the motor section 3, and an optical element 4 at high speed with high degree of accuracy. The fluid bearing is carrying out general structure, is equipped with the bearing fixed part 2 of a fixed side, and the bearing rotation section 5 of the rotating side, and is constituted.
[0009] The bearing fixed part 2 has peripheral wall 2a and the inward-flange-like ends walls 2b and 2c, the bearing rotation section 5 has outward-flange 5a in the end side, and this outward-flange 5a is arranged among the ends walls 2b and 2c.
[0010] Although air and nitrogen of a predetermined pressure are supplied in order to operate a fluid bearing, in this example, gas nitrogen is supplied for the reason mentioned later. If the nitrogen of a predetermined pressure is first supplied to the bearing fixed part 2 from the nitrogen supply line 1, nitrogen will trifurcate to the object for thrust bearings, and radial bearings inside the bearing fixed part 2. On the other hand, the fluid pad 17 is formed in the portion of each inside to which the bearing fixed part 2 counters the superficies of outward-flange 5a of the bearing rotation section 5. The bearing rotation section 5 surfaces to the bearing fixed part 2 by the above-mentioned nitrogen being supplied.
[0011] On the other hand, the bearing rotation section 5 and the motor section 3 constitute the motor as an actuator for rotating this bearing rotation section 5 at high speed. The coil is wound around the bearing rotation section 5 and the motor section 3, respectively, and the same work as a DC motor is carried out by both one. Therefore, if predetermined voltage is applied to the motor section 3 from a power supply 12, the pneumatic bearing rotation section 5 will rotate. The feature of this motor is that the coil section 13 is connected with the bearing rotation section 5 (in order to pour nitrogen in the coil section 13 so that it may mention later). Furthermore the interior of the bearing rotation section 5 is space, and the lighting light 9 which illuminates a reticle passes through the interior of a motor.
[0012] In addition, it is fixed to the bearing rotation section 5, and an optical element 4 rotates by one. That is, the bearing fixed part 2, the bearing rotation section 5, and the motor section 3 constitute from one the fluid bearing motor which has the function of the bearing and the motor which are made to rotate an optical element 4.
[0013] By forming seal glass 6 in the both sides of this fluid bearing motor, the nitrogen 7 which

surfaced the bearing rotation section 5 can be led to the coil section 13 of the motor section 3. By carrying out like this, since generation of heat of a motor has mainly occurred in this coil section 13, it becomes possible [cooling the source of generation of heat directly from the interior]. Therefore, at this example, while passing through the nitrogen 7 used for surfacing of the pneumatic bearing rotation section 5 in the crevice between the inside of the bearing fixed part 2 and the motor section 3, and the superficies of the bearing rotation section 5, by using for cooling inside the source of generation of heat, it will have a self-cooling function and big covering and waste heat equipment which cover the whole source of generation of heat become unnecessary.
[0014] Furthermore by this example, other nitrogen purges supply the nitrogen exhausted from the fluid bearing motor to the required space 8. Mainly, ultraviolet rays and an impurity cause a chemical reaction in air atmosphere, an impurity is generated on the surface of an optical element, and the nitrogen purge is performed in order to prevent that the permeability of an optical element 4 falls. The amount of the nitrogen consumed by nitrogen purge can be reduced by reusing like this example to the nitrogen purge for protection of the gas nitrogen 7 used with the fluid bearing of an optical element 4.
[0015] Of course, the nitrogen purge of the optical element 4 in a fluid bearing is also performed by making it the structure of this example.
[0016] In addition, not air but gas nitrogen was supplied to the fluid bearing for reusing used nitrogen 7 to a nitrogen purge. If it is only a cooling function, it will be satisfactory, even if it replaces with nitrogen and uses air.
[0017] (The second example) Drawing 2 is the block diagram showing the fluid bearing motor concerning the second example, and has attached the same sign to the same portion as having been shown in drawing 1 . The feature of this example is having cooled the temperature of the nitrogen to supply beforehand, in order to gather the cooling efficiency of the coil section 13. Cooling is performed by cooling the nitrogen tank 10 formed in the middle of the nitrogen supply line 1 with the nitrogen tank condensator 11. The purpose of original of the nitrogen tank 10 is a safety practice when the nitrogen supplied to the pad 17 prepared in the bearing fixed part 2 of a fluid bearing stops. When nitrogen supply stops, if a pressure sensor 18 detects the failure of pressure of nitrogen, the current supply to the motor section 3 will be stopped, and the bearing rotation section 5 will be stopped. Under the present circumstances, the purpose of the nitrogen tank 10 supplies nitrogen to the bearing fixed part 2 until the bearing rotation section 5 stops. Nitrogen is cooled by cooling this existing nitrogen tank 10 from the exterior. Although cooling uses the nitrogen tank condensator 11, it is also good to apply the cooling air used for cooling of other portions.
[0018] (The third example) Drawing 3 is the block diagram showing the fluid bearing motor concerning the third example, and has attached the same sign to the same portion as having been shown in drawing 1 and drawing 2 . The feature of the fluid bearing motor concerning this example is making it possible to keep constant the temperature of the motor section 3 and the bearing fixed part 2, even if the electric energy which the rotational frequency of an optical element 4 is changed and is consumed in the motor section 3 changes and calorific value changes.
[0019] The rotational frequency of a request of an optical element 4 is obtained because, as for this fluid bearing motor, CPU15 controls the voltage of the power supply 12 supplied to the motor section 3. If a rotational frequency goes up at this time, since the calorific value from the coil section 13 will increase, it is necessary to improve the refrigeration capacity of the coil section 13. Then, CPU15 is controlling the power supply 12 of the nitrogen tank condensator 11, improves the refrigeration capacity of the tank condensator 11, and lowers the temperature of nitrogen. Thus, the temperature of the motor section 3 or the bearing fixed part 2 can be kept constant by controlling nitrogen to suitable temperature according to the rotational frequency of an optical element 4. Furthermore, optimizing the amount of the nitrogen supplied to the bearing fixed part 2 because CPU15 controls the flow control bulb 16 prepared in the middle of the nitrogen supply line 1 is also attaining fixed-ization of the temperature of the motor section 3 or the bearing fixed part 2. Of course, the nitrogen flow rate is changed in the range which does not spoil the property of a fluid bearing.
[0020] (The fourth example) Drawing 4 is the block diagram showing the fluid bearing motor

concerning the fourth example, and has attached the same sign as the same portion as the case of each above-mentioned example. When the optical element 19 different from the above-mentioned is, the feature of the fluid bearing motor concerning this example is having changed the flow of used nitrogen 7, as the discharge hole 22 opened in the portion of the motor section 3 until it passes over the coil section 13 and results in this optical element 19 in accordance with radial, and the introductory slot 24 near the periphery of an optical element 19 are formed and it does not have influence of used nitrogen 7 on an optical element 19. For example, it is effective, when an optical element 19 is sensitive in temperature, or when a special material is used for the coil section 13 and you do not want to pour used nitrogen 7 to an optical element 19. The nitrogen 20 into which a flow is changed is put into the motor section 3 from the introductory slot 24, and is changing the flow of used nitrogen 7. The newly supplied nitrogen is sufficient as the nitrogen 20 into which a flow is changed, and the nitrogen which came out of the fluid bearing may be used for it.
[0021] In addition, this invention is not limited by the above-mentioned example. For example, it can apply also to the motor which drives equipments other than an aligner, it can replace with air or gas nitrogen as a fluid, and a liquid can also be used depending on other gases and the case.
[0022]
[The example of a device process] Next, the example of the process of the device using the aligner driven by the fluid bearing motor which gave [above-mentioned] explanation is explained. Drawing 5 shows the flow of manufacture of minute devices (semiconductor chips, such as IC and LSI, a liquid crystal panel, CCD, the thin film magnetic head, micro machine, etc.). The pattern design of a device is performed at Step 1 (circuit design). The mask in which the designed pattern was formed is manufactured at Step 2 (mask manufacture). On the other hand, at Step 3 (wafer manufacture), a wafer is manufactured using material, such as silicon and glass. Step 4 (wafer process) is called last process, and forms an actual circuit on a wafer with lithography technology using the mask and wafer which carried out [above-mentioned] preparation. The following step 5 (assembly) is called back process, is a process semiconductor-chip-ized using the wafer produced by Step 4, and includes processes, such as an assembly process (dicing, bonding) and a packaging process (chip enclosure). At Step 6 (inspection), the check test of the semiconductor device produced at Step 5 of operation, an endurance test, etc. are inspected. A semiconductor device is completed through such a process and this is shipped (Step 7).
[0023] Drawing 6 shows the detailed flow of the above-mentioned wafer process. The front face of a wafer is oxidized at Step 11 (oxidization). An insulator layer is formed in a wafer front face at Step 12 (CVD). At Step 13 (electrode formation), an electrode is formed by vacuum evaporationo on a wafer. Ion is driven into a wafer at Step 14 (ion implantation). A sensitization agent is applied to a wafer at Step 15 (resist processing). At Step 16 (exposure), printing exposure of the circuit pattern of a mask is carried out at a wafer by the aligner driven by the fluid bearing motor which gave [above-mentioned] explanation. The exposed wafer is developed at Step 17 (development). At Step 18 (etching), portions other than the developed resist image are shaved off. The resist which etching could be managed with Step 19 (resist ablation), and became unnecessary is removed. By carrying out by repeating these steps, a circuit pattern is formed on a wafer multiplex.
[0024] If the process of this example is used, the highly-integrated device for which manufacture was difficult can be conventionally manufactured to a low cost.
[0025]
[Effect of the Invention] Since according to this invention the fluid of a fluid bearing passes through near the exoergic section of the motor section, and cools this motor section and fluid bearing motors, such as a pneumatic bearing motor, have a self-cooling function as explained above, temperature control covering and the exhaust become unnecessary.
[0026] Moreover, since the source of generation of heat inside a motor is cooled directly, it is possible to perform optimal cooling corresponding to the calorific value change accompanying rotational frequency change of a fluid bearing by controlling the temperature and the flow rate of the fluid which can cool fluid bearings, such as a pneumatic bearing, efficiently and is supplied to fluid bearings, such as a pneumatic bearing.

[0027] By using for another nitrogen purge the nitrogen as a fluid furthermore used for surfacing of a fluid bearing, a nitrogen flow rate required for a nitrogen purge can also be reduced.

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TECHNICAL FIELD

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PRIOR ART

[Description of the Prior Art] Conventionally, in the semiconductor aligner, a still higher equipment precision (for example, alignment precision of a wafer and a reticle and imprint precision to the wafer of a reticle pattern), high productivity, etc. are searched for with detailed-izing of a semiconductor device. In order to realize it, positioning accuracy and a high-speed drive also with the still more expensive drive of each part of the inside of an aligner are called for. For example, also in the lighting optical system which illuminates a reticle, the guide section rigidity rise (although it is made to drive weight rise) for raising high-speed movement for raising enlargement of the optical element (object to drive) for acquiring the equalization effect and a throughput in the drive to which it is made to rotate at high speed, or an optical element is moved, and positioning accuracy etc. is needed. Therefore, as for the actuator used for the above-mentioned drive, the motor with more large power (power consumption) etc. has been needed. Consequently, the heating value generated from the actuator which became large [power] has also increased increasingly.
[0003] On the other hand, the drive precision and alignment precision of a wafer or a reticle will get worse by thermal expansion, measurement value change, etc., if a temperature change happens inside equipment. The temperature change permitted in order to satisfy a high equipment precision is becoming still severer with detailed-izing of a semiconductor device. Although the whole aligner is covered with covering and temperature management of the whole equipment is performed in an aligner in order to realize required temperature management, the part where especially temperature management is important establishes a temperature control mechanism individually, and is performing temperature management (individual air-conditioning).
[0004] Furthermore, especially when there are big sources of generation of heat, such as a large motor of the above power, the portion is individually covered with covering, the temperature on the front face of covering is lowered by performing the heat exhaust air inside the covering, and temperature management has reduced the influence of the temperature change to an important portion.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since according to this invention the fluid of a fluid bearing passes through near the exoergic section of the motor section, and cools this motor section and fluid bearing motors, such as a pneumatic bearing motor, have a self-cooling function as explained above, temperature control covering and the exhaust become unnecessary.
[0026] Moreover, since the source of generation of heat inside a motor is cooled directly, it is possible to perform optimal cooling corresponding to the calorific value change accompanying rotational frequency change of a fluid bearing by controlling the temperature and the flow rate of the fluid which can cool fluid bearings, such as a pneumatic bearing, efficiently and is supplied to fluid bearings, such as a pneumatic bearing.
[0027] By using for another nitrogen purge the nitrogen as a fluid furthermore used for surfacing of a fluid bearing, a nitrogen flow rate required for a nitrogen purge can also be reduced.

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TECHNICAL PROBLEM

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[0006] this invention has a self-cooling function, temperature control covering and its exhaust are unnecessary, it can perform optimal cooling corresponding to the calorific value change accompanying rotational frequency change, and aims at offering the fluid bearing motor which can reduce the flow demand of a fluid.

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OPERATION

[The means and operation] for solving a technical problem In order to solve the above-mentioned technical problem, the fluid bearing motor concerning this invention is characterized by being the structure which it has the drive equipped with a fluid bearing and the motor section, and the fluid of the aforementioned fluid bearing passes through near the exoergic section of the aforementioned motor section, and cools this motor section. Moreover, self-cooling of the exoergic section can be carried out by considering as the structure where this invention is the pneumatic bearing motor which consists of high positioning accuracy, a fluid bearing (especially pneumatic bearing) which realizes high-speed rotation, and the high power motor section, and air flows the exoergic section neighborhood of a motor. Therefore, covering and exhaust heat equipment are made unnecessary.

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EXAMPLE

[Example]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the fluid bearing motor concerning the first example of this invention.
[Drawing 2] It is a block diagram in the case of the fluid bearing motor concerning the second example of this invention being shown, and cooling the nitrogen as a fluid.
[Drawing 3] It is a block diagram in the case of the fluid bearing motor concerning the third example of this invention being shown, and optimizing nitrogen temperature and a nitrogen flow rate.
[Drawing 4] It is a block diagram at the time of the fluid bearing motor concerning the fourth example of this invention being shown, and changing the flow of nitrogen.
[Drawing 5] It is drawing showing the flow of manufacture of a minute device.
[Drawing 6] It is drawing showing the detailed flow of the wafer process in drawing 5 .
[Description of Notations]
A nitrogen supply line, 2:bearing fixed part, 3:motor section, 4 : 1: An optical element, 5: The bearing rotation section, 6:seal glass, 7 : The nitrogen used with the fluid bearing, 8: Nitrogen purge space, 9:exposure light, 10:nitrogen tank, 11:nitrogen tank condensator, 12:power supply, 13:coil section, 15:CPU, 16:flow control valve, 17:fluid pad, 18:pressure sensor, 19:optical element, the nitrogen into which 20:flow is changed, 22:discharge hole, 24: An introductory slot.

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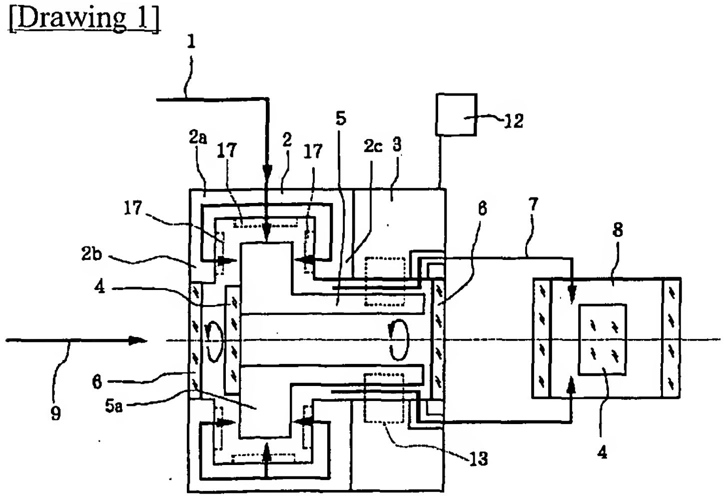
DRAWINGS

[Drawing 1]



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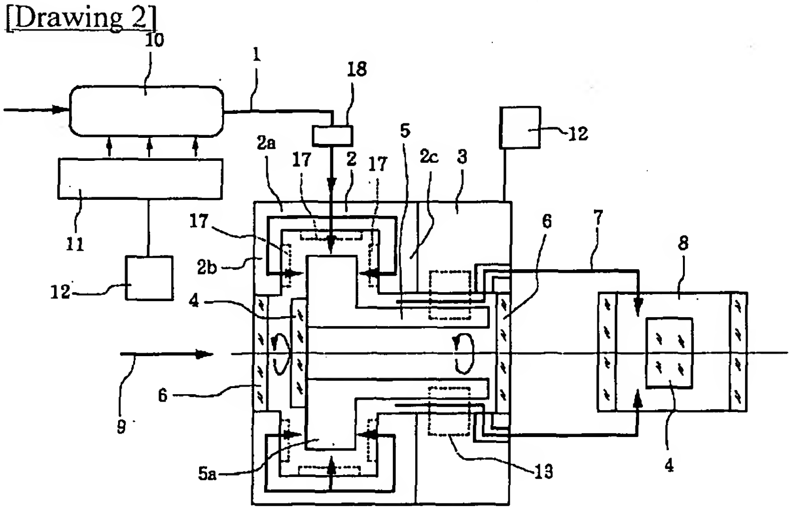
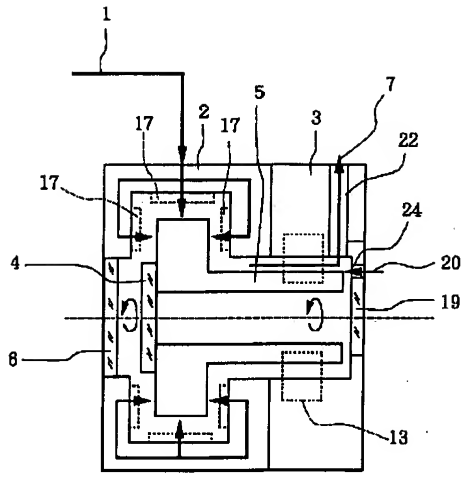
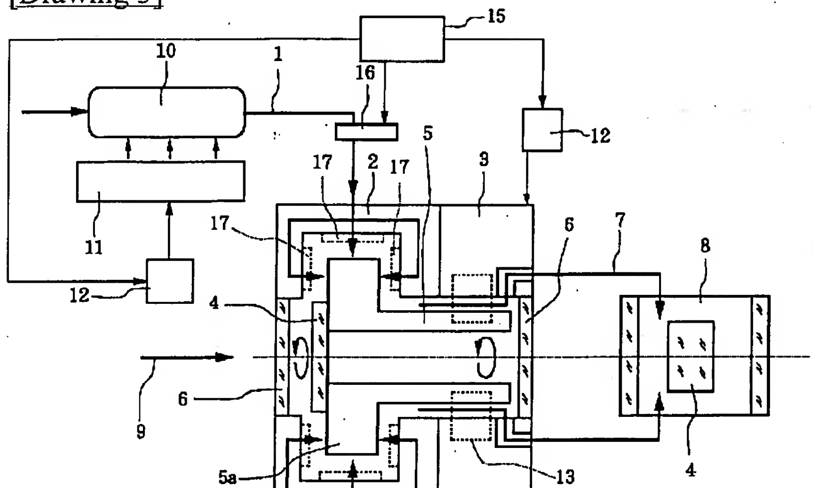


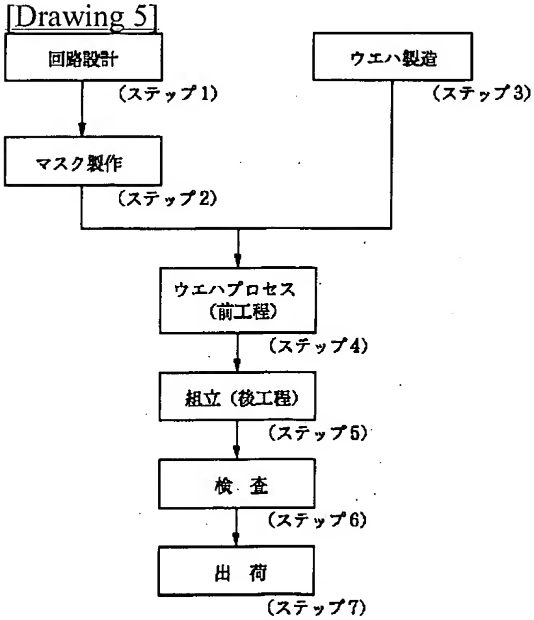
[Drawing 4]



[Drawing 3]

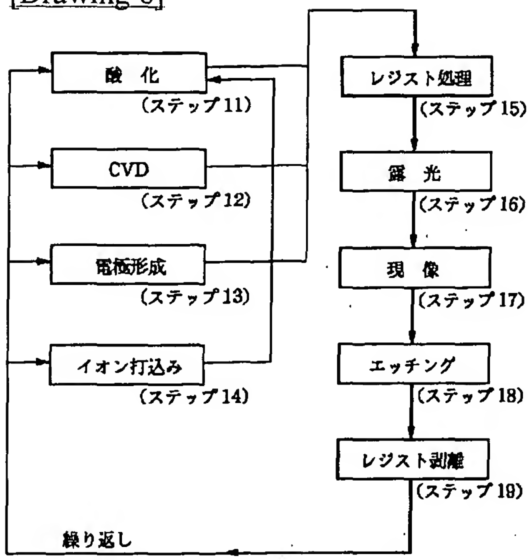


[Drawing 5]



半導体デバイス製造フロー

[Drawing 6]



ウエハプロセス

[Translation done.]

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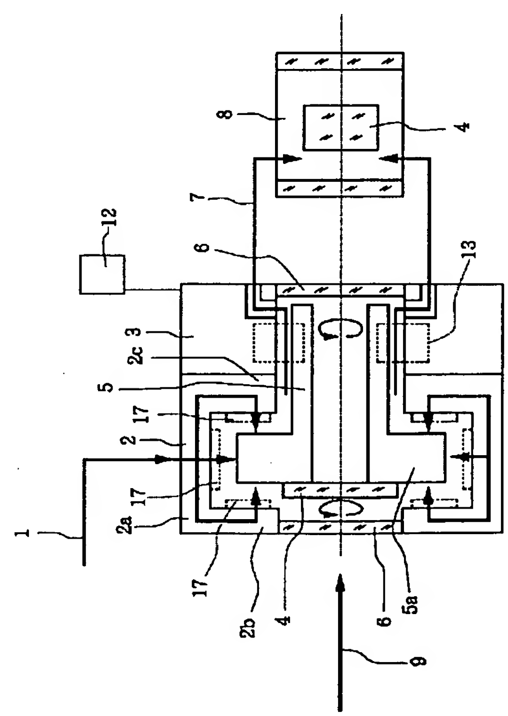
最終頁に続く

(54)【発明の名称】　流体軸受けモータ

(57)【要約】
【課題】　温度調節カバーや排気装置を不要にし、回転数変化に伴う発熱量変化に対応した最適な冷却を行うことを可能にし、流体の必要流量を低減する。
【解決手段】　ベアリング固定部２とベアリング回転部５とを有する流体軸受け部、およびモータ部３を備えた駆動機構を有し、前記流体軸受け部の流体がモータ部３の発熱部付近を通過する構造であり、前記流体軸受け部に流体として窒素を供給し、その窒素を再び集めて他の場所にあるパージ空間８の窒素置換に再利用する。



【特許請求の範囲】

【請求項１】　流体軸受け部とモータ部を備えた駆動機構を有し、前記流体軸受け部の流体が前記モータ部の発熱部付近を通過して該モータ部を冷却する構造であることを特徴とする流体軸受けモータ。

【請求項２】　前記流体軸受け部に流体として窒素を供給し、その窒素を再び集めて他の場所の窒素置換に再利用することを特徴とする請求項１に記載の流体軸受けモータ。

【請求項３】　前記流体軸受け部に供給する流体を予め冷却することを特徴とする請求項１に記載の流体軸受けモータ。

【請求項４】　前記モータ部の発熱量に応じて、前記流体軸受け部に供給する流体の温度を変えることを特徴とする請求項１に記載の流体軸受けモータ。

【請求項５】　前記モータ部の発熱量に応じて、前記流体軸受け部に供給する流体の流量を変えることを特徴とする請求項１に記載の流体軸受けモータ。

【請求項６】　流体の流れの向きを変える別の流体を流すことを特徴とする請求項１に記載の流体軸受けモータ。

【請求項７】　請求項１～６のいずれかに記載の流体軸受けモータを用いて駆動され、レチクルなどの原版のパターンをウエハなどの被転写物の面上に投影転写することを特徴とする半導体露光装置。

【請求項８】　請求項７に記載の半導体露光装置を用いてデバイスを製造することを特徴とするデバイス製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、原版（例えばレチクルなど）のパターンを被転写物（例えばウエハなど）の面上に投影転写する半導体露光装置などの駆動に好適に用いられるモータに関し、流体軸受け部とモータ部とを備え、流体がモータ部の発熱を自己冷却可能な自己冷却型の流体軸受けモータに関するものである。

【０００２】

【従来の技術】従来、半導体露光装置では、半導体素子の微細化に伴い、益々高い装置精度（例えばウエハとレチクルの位置合わせ精度やレチクルパターンのウエハへの転写精度）や高い生産性などが求められている。それを実現する為に、露光装置内各部の駆動機構も益々高い位置決め精度や高速駆動が求められている。例えばレチクルを照明する照明光学系においても、光学素子を高速で回転させたり移動させる駆動機構では、平均化効果を得る為の光学素子（駆動される物）の大型化、スループットを上げる為の高速移動、位置決め精度を向上させる為のガイド部剛性アップ（駆動させるものの重量アップ）などが必要となる。従って、上記駆動機構に使用されるアクチュエータは、よりパワー（消費電力）の大きいモータなどが必要となってきた。その結果、パワーの大きくなったアクチュエータより発生する熱量も益々多くなってきた。

【０００３】一方で、ウエハやレチクルの駆動精度や位置合わせ精度は、装置内部で温度変化が起こると熱膨張や計測値変化などにより悪化する。高い装置精度を満足させる為に許容される温度変化は半導体素子の微細化に伴い益々厳しくなってきている。必要な温度管理を実現する為に露光装置では、露光装置全体をカバーで覆い装置全体の温度管理を行うが、特に温度管理が重要な個所は個別に温度調節機構を設けて温度管理（個別空調）を行っている。

【０００４】さらに、特に上記のようなパワーの大きいモータなどの大きな発熱源がある場合は、個別にその部分をカバーで覆い、そのカバー内部の熱排気を行うことでカバー表面の温度を下げ、温度管理が重要な部分への温度変化の影響を低減させてきた。

【０００５】

【発明が解決しようとする課題】しかしながら、上記従来例では、カバー内部の熱排気を行う専用の熱排気装置が必要であったり、発熱源全体を覆う構造である為、カバーの構造が大きくなり大きな空間スペースが必要であった。また熱排気の為のパイプ（ダクト）を発熱源と熱排気装置の間に接続する為、パイプ引き回しなどの為にも大きな空間スペースを必要とした。さらに、露光装置はウエハとレチクルの高い位置決め精度を実現する為にレチクルやウエハを支持する構造体などを高精度で位置制御しているが、位置制御された構造体に発熱源が配置された場合は、熱排気のパイプが、熱排気装置の振動を、位置制御された構造体に伝え、ウエハとレチクルの位置決め精度を悪化させることも無視できなかった。

【０００６】本発明は、自己冷却機能を有し、温度調節カバーや排気装置が不要であり、回転数変化に伴う発熱量変化に対応した最適な冷却を行うことができ、流体の必要流量を低減することができる流体軸受けモータを提供することを目的とする。

【０００７】

【課題を解決する為の手段および作用】上記課題を解決する為に、本発明に係る流体軸受けモータは、流体軸受け部とモータ部を備えた駆動機構を有し、前記流体軸受け部の流体が前記モータ部の発熱部付近を通過して該モータ部を冷却する構造であることを特徴とする。また、本発明は、高位置決め精度、高速回転を実現する流体軸受け部（特にエアベアリング）と高出力モータ部からなるエアベアリングモータで、エアがモータの発熱部近辺を流れる構造とすることで、発熱部を自己冷却させることができる。従ってカバーや排熱装置を不要にする。

【０００８】

【実施例】（第一の実施例）次に本発明の第一の実施例について説明する。図１は本発明の第一の実施例に係る

流体軸受けモータを示す構成図である。この流体軸受けモータは、窒素供給ライン１が接続されているベアリング固定部２、モータ部３、および光学素子４を高精度で高速に回転させる為の駆動ガイドとしての流体軸受けを構成するベアリング回転部５などを備えている。流体軸受け部は一般的な構造をしており、固定側のベアリング固定部２と、回転する側のベアリング回転部５とを備えて構成されている。

【０００９】ベアリング固定部２は周壁２ａと内向きフランジ状の両端壁２ｂ，２ｃとを有し、ベアリング回転部５は一端側に外向きフランジ５ａを有しており、該外向きフランジ５ａは両端壁２ｂ，２ｃの間に配置されている。

【００１０】流体軸受け部を動作させるには、所定圧力のエアや窒素を供給するが、本実施例では後述する理由により気体窒素を供給する。まずベアリング固定部２に窒素供給ライン１より所定圧力の窒素が供給されると、ベアリング固定部２の内部で窒素がスラスト軸受け用、ラジアル軸受け用に３分岐される。一方、ベアリング固定部２は、ベアリング回転部５の外向きフランジ５ａの外面に対向する各内面の部分に流体パッド１７が設けられている。上記窒素が供給されることでベアリング回転部５はベアリング固定部２に対して浮上する。

【００１１】一方、ベアリング回転部５とモータ部３は、該ベアリング回転部５を高速で回転させる為のアクチュエーターとして、モータを構成している。ベアリング回転部５とモータ部３にはそれぞれコイルが巻かれており、両者一体でＤＣモータと同じ働きをする。従って電源１２からモータ部３に所定の電圧をかけるとエアベアリング回転部５が回転する。このモータの特徴は、コイル部１３がベアリング回転部５とつながっていることである（後述する様に、窒素をコイル部１３に流す為）。さらにベアリング回転部５の内部が空間になっており、レチクルを照明する照明光９がモータの内部を通過する。

【００１２】なお、光学素子４はベアリング回転部５に固定されて、一体で回転する。つまりベアリング固定部２とベアリング回転部５とモータ部３は、一体で光学素子４を回転させるベアリングとモータの機能を有する流体軸受けモータを構成している。

【００１３】この流体軸受けモータの両側にシールガラス６を設けることで、ベアリング回転部５を浮上させた窒素７をモータ部３のコイル部１３に導くことができる。こうすることで、モータの発熱は主にこのコイル部１３で起きているから、発熱源を内部から直接冷却することが可能となる。よって本実施例では、エアベアリング回転部５の浮上用に使用した窒素７を、ベアリング固定部２およびモータ部３の内面とベアリング回転部５の外面との隙間に通して流す間に、発熱源内部の冷却に利用することで、自己冷却機能を持つことになり、発熱源全体を覆う大きなカバーや廃熱装置が不要になる。

【００１４】さらに本実施例では、流体軸受けモータから排気された窒素を他の窒素パージが必要な空間８に供給している。窒素パージは主に、大気雰囲気中で紫外線と不純物が化学反応を起こし、光学素子の表面に不純物が生成され、光学素子４の透過率が下がることを防止する目的で行われている。本実施例のように、流体軸受け部で使用された気体窒素７を光学素子４の保護のための窒素パージに再利用することによって、窒素パージで消費する窒素の量を減らすことができる。

【００１５】無論、本実施例の構造にすることで、流体軸受け部内の光学素子４の窒素パージも行われている。

【００１６】なお、エアでなく気体窒素を流体軸受け部に供給したのは、使用済みの窒素７を窒素パージに再利用する為である。冷却機能だけであれば、窒素に代えてエアを使用しても問題はない。

【００１７】（第二の実施例）図２は第二の実施例に係る流体軸受けモータを示す構成図であって、図１に示したのと同一部分に同一符号を付けてある。本実施例の特徴はコイル部１３の冷却効率を上げる為に、供給する窒素の温度を予め冷却していることである。冷却は、窒素供給ライン１の途中に設けられた窒素タンク１０を窒素タンク冷却器１１によって冷却することで行っている。窒素タンク１０の本来の目的は、流体軸受け部のベアリング固定部２に設けたパッド１７に供給する窒素が停止した場合の安全対策である。窒素供給が停止した場合、圧力センサー１８が窒素の圧力低下を検知するとモータ部３への電源供給を停止し、ベアリング回転部５を停止させる。この際、ベアリング回転部５が停止するまで窒素をベアリング固定部２に供給するのが窒素タンク１０の目的である。この既存の窒素タンク１０を外部より冷却することで、窒素の冷却を行う。冷却は窒素タンク冷却器１１を用いているが、他の部分の冷却に用いている冷却エアを当てるだけでも良い。

【００１８】（第三の実施例）図３は第三の実施例に係る流体軸受けモータを示す構成図であって、図１及び図２に示したのと同一部分に同一符号を付けてある。本実施例に係る流体軸受けモータの特徴は、光学素子４の回転数を変化させてモータ部３で消費される電力量が変化し発熱量が変化しても、モータ部３およびベアリング固定部２の温度を一定に保つことを可能にしていることである。

【００１９】この流体軸受けモータは、ＣＰＵ１５がモータ部３に供給される電源１２の電圧を制御することで光学素子４の所望の回転数が得られる。この時、回転数が上がれば、コイル部１３からの発熱量が増えるので、コイル部１３の冷却能力を上げる必要がある。そこでＣＰＵ１５は、窒素タンク冷却器１１の電源１２を制御することで、タンク冷却器１１の冷却能力を上げて窒素の温度を下げる。このようにして、光学素子４の回転数に

応じて適切な温度に窒素を制御することで、モータ部３やベアリング固定部２の温度を一定に保つことが出来る。さらにＣＰＵ１５は、窒素供給ライン１の途中に設けられた流量調整バルブ１６を制御することでベアリング固定部２に供給する窒素の量を最適化することでも、モータ部３やベアリング固定部２の温度の一定化を図っている。無論、流体軸受け部の特性を損なわない範囲で窒素流量を変化させている。

【００２０】（第四の実施例）図４は第四の実施例に係る流体軸受けモータを示す構成図であって、上記各実施例の場合と同じ部分に同じ符号を付けてある。本実施例に係る流体軸受けモータの特徴は、前述とは別の光学素子１９がある場合に、コイル部１３を過ぎて該光学素子１９に至るまでのモータ部３の部分に半径方向に沿って開けた排出孔２２と、光学素子１９の外周近傍の導入溝２４とを設け、光学素子１９に使用済み窒素７の影響を与えないように、使用済み窒素７の流れを変えたことである。例えば、光学素子１９が温度的に敏感である場合や、コイル部１３に特殊な材料が使用されている場合などに使用済み窒素７を光学素子１９に流したくない場合に有効である。流れを変える窒素２０は導入溝２４からモータ部３に入れて、使用済み窒素７の流れを変えている。流れを変える窒素２０は、新たに供給された窒素でも良いし、流体軸受け部から出てきた窒素を利用しても良い。

【００２１】なお、本発明は、上記実施例によって限定されない。例えば、露光装置以外の装置を駆動するモータにも適用することができ、流体としてエアや気体窒素に代えて他の気体や、場合によっては液体を用いることもできる。

【００２２】

【デバイス生産方法の実施例】次に上記説明した流体軸受けモータによって駆動される露光装置を利用したデバイスの生産方法の実施例を説明する。図５は微小デバイス（ＩＣやＬＳＩ等の半導体チップ、液晶パネル、ＣＣＤ、薄膜磁気ヘッド、マイクロマシン等）の製造のフローを示す。ステップ１（回路設計）ではデバイスのパターン設計を行う。ステップ２（マスク製作）では設計したパターンを形成したマスクを製作する。一方、ステップ３（ウエハ製造）ではシリコンやガラス等の材料を用いてウエハを製造する。ステップ４（ウエハプロセス）は前工程と呼ばれ、上記用意したマスクとウエハを用いて、リソグラフィ技術によりウエハ上に実際の回路を形成する。次のステップ５（組み立て）は後工程と呼ばれ、ステップ４により作製されたウエハを用いて半導体チップ化する工程であり、アッセンブリ工程（ダイシング、ボンディング）、パッケージング工程（チップ封入）等の工程を含む。ステップ６（検査）ではステップ５で作製された半導体デバイスの動作確認テスト、耐久性テスト等の検査を行う。こうした工程を経て半導体デバイスが完成し、これが出荷（ステップ７）される。

【００２３】図６は上記ウエハプロセスの詳細なフローを示す。ステップ１１（酸化）ではウエハの表面を酸化させる。ステップ１２（ＣＶＤ）ではウエハ表面に絶縁膜を形成する。ステップ１３（電極形成）ではウエハ上に電極を蒸着によって形成する。ステップ１４（イオン打込み）ではウエハにイオンを打ち込む。ステップ１５（レジスト処理）ではウエハに感光剤を塗布する。ステップ１６（露光）では上記説明した流体軸受けモータで駆動される露光装置によってマスクの回路パターンをウエハに焼付露光する。ステップ１７（現像）では露光したウエハを現像する。ステップ１８（エッチング）では現像したレジスト像以外の部分を削り取る。ステップ１９（レジスト剥離）ではエッチングが済んで不要となったレジストを取り除く。これらのステップを繰り返し行うことにより、ウエハ上に多重に回路パターンが形成される。

【００２４】本実施例の生産方法を用いれば、従来は製造が難しかった高集積度のデバイスを低コストに製造することができる。

【００２５】

【発明の効果】以上説明したように、本発明によれば、流体軸受け部の流体がモータ部の発熱部付近を通過して該モータ部を冷却し、エアベアリングモータ等の流体軸受けモータが自己冷却機能を有するので、温度調節カバーや排気装置が不要になる。

【００２６】また、モータ内部の発熱源を直接冷却するので、エアベアリング等の流体軸受け部を効率よく冷却でき、エアベアリングなどの流体軸受け部に供給する流体の温度や流量を制御することで流体軸受け部の回転数変化に伴う発熱量変化に対応した最適な冷却を行うことが可能である。

【００２７】さらに流体軸受け部の浮上に利用された流体としての窒素を別の窒素パージに利用することにより、窒素パージに必要な窒素流量を低減することもできる。

【図面の簡単な説明】

【図１】　本発明の第一の実施例に係る流体軸受けモータを示す構成図である。

【図２】　本発明の第二の実施例に係る流体軸受けモータを示し、流体としての窒素を冷却する場合の構成図である。

【図３】　本発明の第三の実施例に係る流体軸受けモータを示し、窒素温度と窒素流量を最適化する場合の構成図である。

【図４】　本発明の第四の実施例に係る流体軸受けモータを示し、窒素の流れを変えた場合の構成図である。

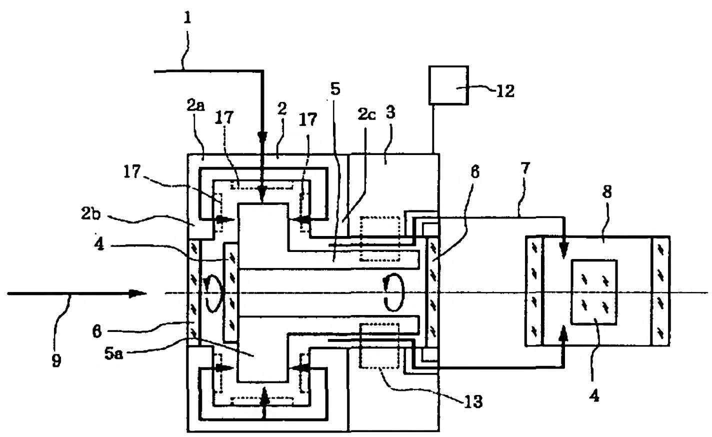
【図５】　微小デバイスの製造の流れを示す図である。

【図６】　図５におけるウエハプロセスの詳細な流れを示す図である。

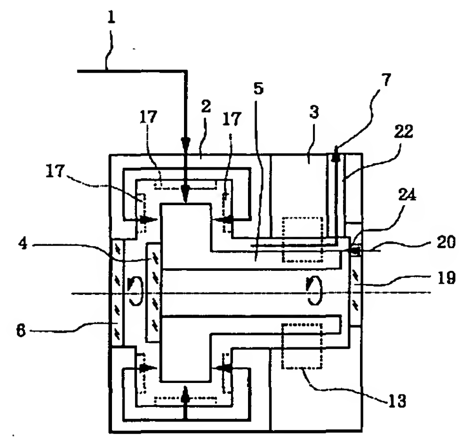
【符号の説明】

１：窒素供給ライン、２：ベアリング固定部、３：モータ部、４：光学素子、５：ベアリング回転部、６：シールガラス、７：流体軸受け部で使用された窒素、８：窒素パージ空間、９：露光光、１０：窒素タンク、１１：窒素タンク冷却器、１２：電源、１３：コイル部、１５：ＣＰＵ、１６：流量調整弁、１７：流体パッド、１８：圧力センサ、１９：光学素子、２０：流れを変える窒素、２２：排出孔、２４：導入溝。

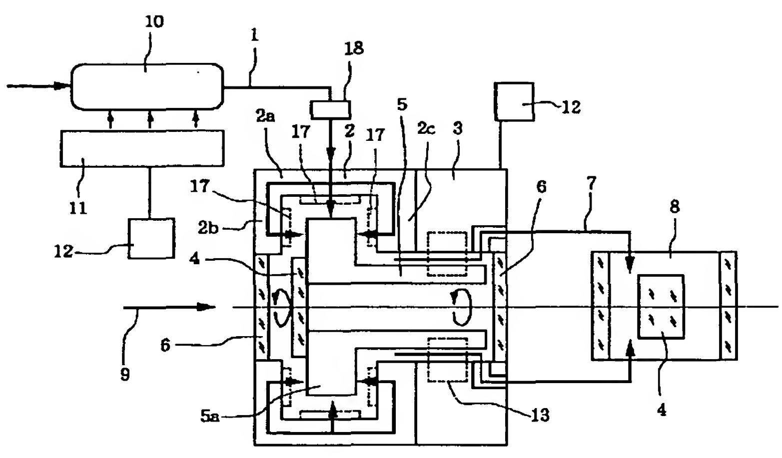
【図１】



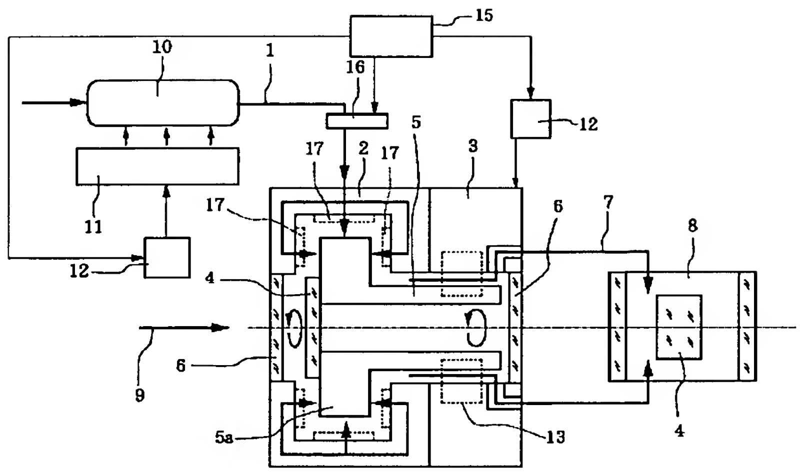
【図４】



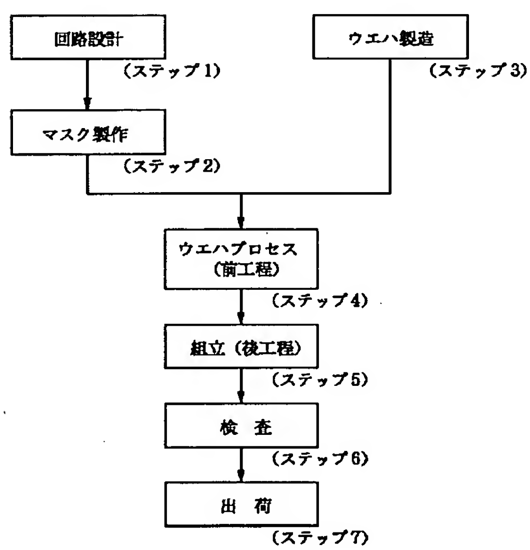
【図２】



【図３】

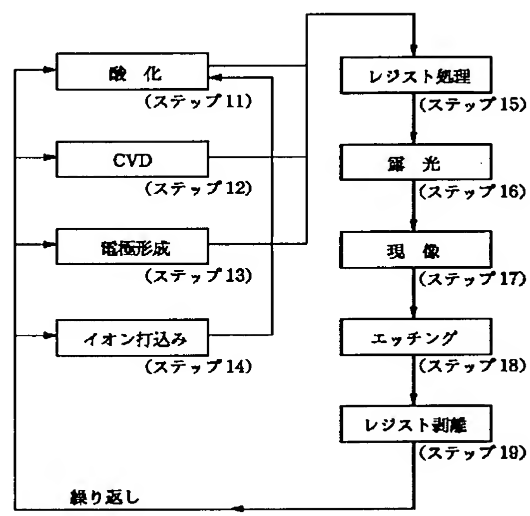


【図５】



半導体デバイス製造フロー

【図６】



ウエハプロセス

フロントページの続き

Ｆターム(参考)　3J102 AA02 BA03 BA19 CA07 CA11
CA33 EA02 EA06 EB01 EB05
GA01
5F046 AA22 CB20 CB23 CB27 CC03
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GG02 GG14
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